Accessibility and Uncertainty: the Option Value of Public Transport

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ABSTRACT

Are there option values of public transport services? A few studies have tried to answer this question through various stated preference methods but the question is so far unanswered. In this paper we set out to present the empirical work that has been done with regard to public transport, and then discuss how option value is linked to accessibility. Accessibility can be seen as the end product of the transport system, and our argument is that option value is a component of accessibility. Therefore, estimations of option value should take into account the change in accessibility that an option mode gives rise to. We present a framework where we discuss the logsum as a potential measure. In addition, we argue that there is a risk premium component of the option value, given that individuals are risk averse, that people might be willing to pay to keep a service from removal.

1. Introduction

A challenge for public transport in Sweden is that operation costs increase more than revenues (Vigren 2015), and this has fuelled a debate about the benefits of public transport and its funding sources (Stanley and Levinson 2016). At the heart of this debate is the question to what extent public transport should be subsidised. Arguments for subsidisation of public transport operations include economies of scale and that lower fares discourage car use (Parry and Small, 2009), but such arguments only support *some* of the subsidies that public transport currently benefits from, according to Roson (2000). For instance, public transport might be of value also for those who normally do not use it. That is, people who normally take their car, or bike, to work might value the availability of public transport in case problems with the car or bike arise.

The idea of value that stretches beyond actual users was introduced by Weisbrod (1964), who discussed the idea of the “option value” of certain non-market “goods” such as public transport, hospitals and natural environments. The theory was further developed by Cicchetti and Freeman (1971) and empirically researched by environmental economists (Barbier 1994), but in transport economics it has not drawn much attention (van Wee 2016). That said, at

Thredbo 14 it was highlighted as a possible path for further research to bridge the benefit/funding gap within public transport (Stanley and Levinson 2016).

The aim of this paper is to draw conclusions about the option value from previous empirical literature, as well as from an inquiry about the relationship between accessibility and option value. We continue Van Wee's (2016) argumentation that the option value is a part of the total accessibility. The paper is organized as follows: In section 2 we outline the theoretical framework around option value and accessibility, and present previous studies. Thereafter, in section 3, we review the empirical literature on option and non-use values, and highlight some noteworthy conclusions. In section 4 we analyse what affects the size of the option value using a more general accessibility approach. Finally, in section 5, we conclude the study with a discussion.

2. Background

2.1 The total economic value and the option value

Social Cost-Benefit Analysis (CBA) aims to include the Total Economic Value (TEV), which consists of all values (benefits) that arise as a consequence of a measure. In the 1960s, environmental economists discussed whether the total value (TEV) of a change was fully included in the CBA framework (Krutilla, 1967) and began to push for new methods of measuring these values and include them in neo-classic models (Plottu and Plottu, 2007). Some values, such as the indirect functional value of natural wetlands, and the option value, were not captured in observed market behaviour (Barbier, 1994). Based on the neo-classic models, the idea is that these values are distinguishable and separable, and adding them up gives the TEV. However, this is not unproblematic: firstly, one needs to be able to value each component separately; secondly, multi-faceted changes may result in measures that cannot be uniquely decomposed (Cicchetti and Wilde, 1992).

In more recent literature, there is inconsistency regarding the division of values in TEV (Chang et al., 2017). Specifically, there are two or three branches of values depending on whom you ask: use values, non-use values, and sometimes the option value. Some researchers differentiate all three of them (Laird et al., 2009; Chang et al., 2012), while other place the option value as a use value (Geurs et al., 2006) or as a non-use value (Humphreys and Fowkes, 2006). A guidance to sort these concepts could be to differentiate the components between "active" and "passive" use. Carson et al. (2001) suggested a definition of passive-use as the portion of the TEV that are left after measuring observed market behaviour. The passive-use values can for example be option values, "pure existence value" and "altruistic existence values", where the latter two are non-use values (Boardman et al. 2014: 235). Carson et al. (2001) argued that motivational reasons might lead to ad-hoc taxonomies, and that this is the reason why there are inconsistencies in the literature. Their definition of passive-use values avoids the need to decide if the option value is a use or non-use value.

In the original paper behind option values, Weisbrod (1964) pointed out three criteria for option value to be relevant. First, the demand of a commodity is infrequent and uncertain; secondly, should the production of the commodity be curtailed, it would be very costly or impossible to re-establish it; and finally, the commodity should be of a collective nature without complete excludability and storability (see also Cicchetti and Freeman (1971) for an outline of these criteria). The second criterion branched off into a literature about quasi-option value; a concept used to evaluate the value of new information in large irreversible decisions (Arrow and Fisher 1974). It also inspired further studies in environmental economics (Krutilla, 1967; Fisher et al., 1972; Krutilla and Fisher, 1985).

The option value is often described as the value individuals assign the future availability of a good or a service, regardless of whether they actually will use it in the future (see e.g. ECONorthwest and PBQD (2002) for a guidance to practitioners, and Laird et al. (2009) for an academic review). The question is then how it is possible to distinguish the option value from the expected consumer surplus (i.e. use values). Cicchetti and Freeman (1971) theoretically proved that if a monopolist could launch an option scheme, s/he would collect larger revenues than with only a perfect price discriminating practice. In the latter case, the monopolist only collects the present value of the expected consumer surplus of those who are certain of using the good, whereas in the former case the monopolist collects the value of both the certain and uncertain users. This result is based on three assumptions about human behaviour (Cicchetti and Freeman, 1971): 1) individuals are uncertain of future demand (which is the core of option values (Lindsay, 1969)), 2) individuals are risk-averse (diminishing marginal utility of income), and 3) individuals seek to maximise their expected utility.[1]

In practice, there is no concrete guidance of how to include these benefits in an appraisal. The Department of Transport in the UK (WebTAG) states that the option and non-use values are context specific as they vary with location and scheme (UK Department for Transport, 2014). The WebTAG also mentions that these values should be considered when there is a “step-change” in service (i.e. removal or renewal of service), and it is categorised as a social impact.

Option values and other passive-use values are difficult to measure, since they do not leave a behavioural trace (Chang et al., 2017). The state of the art way to get around this is to make hypothetical market studies and use stated preference methods such as contingent valuation (CV) (Arrow et al., 1993; Diamond and Hausman, 1994; Hanemann, 1994) or choice experiment (CE) (Train, 2009; Hensher et al., 2015). CV seeks an answer to the question what individuals would be willing to pay/accept for a certain improvement/deterioration of a transport service, for instance, while CE asks individuals to choose among two or more positions in a discrete choice setting.

2.2 Accessibility

Accessibility can be defined in a number of different ways, and the term is applicable to different aspects of the transport system and the built environment. It can be claimed that accessibility is the end product of a transport system, and it is an aim for transport administrations (van Wee, 2016). At the same time, accessibility is dependent on the use of land since it is determined by the spatial distribution of activities (Handy and Niemeier, 1997). The more accessible destinations an individual has, and the more transport options to these destinations, the better is her accessibility.

[1] We should note that there has been a substantial disagreement about the relevance and size of the option value, see e.g. Long (1967), Zeckhauser (1969), Lindsay (1969), Byerlee (1971) and Schmalensee (1972).

We can thus say that accessibility is a product of both the land-use and transport systems, but it also depends on individual and temporal components (Geurs and van Wee, 2013). The land-use component reflects the spatial distribution of activities. The transport component captures the disutility of traveling, and the faster, cheaper and more comfortable, the lower the disutility of traveling. The individual accessibility component captures individual attributes, needs, and social status; individuals might be incapable of traveling for various reasons even though there is a good transport network. It can also be that the employers within reachable distance demand other skills than the ones that specific individuals possess. Finally, the temporal component reflects the availability of activities at specific times of a day. An individual working evenings and nights is excluded from activities at those times even though the individual has the capability and spatial proximity.

There is a distinction between individual and location (activity) perspective on accessibility, as pointed out by Geurs and van Wee (2004; 2013). Figure 1 displays the individual centred perspective on accessibility, which is in focus in this paper. The individual (I) have different activities (A) to choose from. From this, the following definition of accessibility is useful, as it includes the four components described above:

> The extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s) at various times of the day (Geurs and van Wee, 2013: 208).

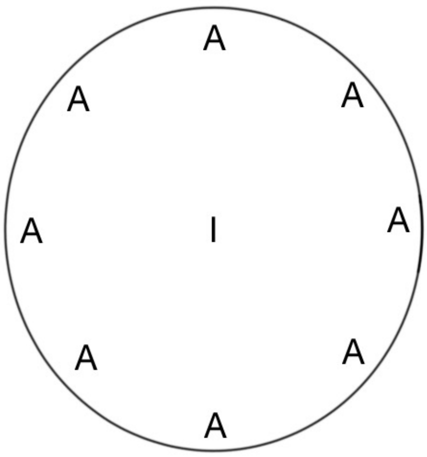

Figure 1. From Geurs and van Wee (2013)

We note that there are many definitions of accessibility (see e.g. Hansen (1959) and Dalvi and Martin (1976)), but instead of going into the depth of this we will make a short note on the relation between accessibility and option value. The option value is as noted above the value people place on the opportunity to use a service at some point in the future even though they might never take up that option (Laird et al., 2009). However, van Wee (2013) note that individuals can assign option values to destinations (shops and other amenities) as well. That is, individuals value both alternative transport modes that they use infrequently, or not at all (i.e. the transport system), and access to amenities they visit infrequently, or not at all (i.e. the land-use). By this token, the land-use and transport systems are working interdependently to provide options of different kind.

3. Review of evidence and evidence gaps

This section contains a review of empirical studies about the option value and other parts of the TEV. We begin in section 3.1 with an explanation of our procedure of collecting and selecting the material followed by a presentation of the empirical studies in section 3.2. Thereafter, in section 3.3, we draw some conclusions based on what we have found in the empirical and theoretical works, and in section 3.4 we make remarks on two areas where we find gaps for this paper to fill.

3.1 Collection and selection procedure

We searched through databases connected to Lund University Library and used different combinations of the keywords “option value”, “non-use value” “altruistic value”, “altruism”, “public transport” and “transport”. We then screened the papers and excluded the articles that did not study the option value as defined in section 2.1, for instance the articles that studied quasi-option value.

Based on database searches we found ten empirical studies and a total of 20 estimations of option or non-use values, for transport services. Five of them are from the UK and the rest were carried out in the US, The Netherlands, South Korea and New Zeeland. Additionally, during the database search we found studies that we categorised as theoretical papers and which we used in section 2. The ambition for this section has been to include only the studies with an estimate of either option value, non-use value or the TEV for public transport services. However, we also mention Roson (2001) that have contributed with estimation on what kind of personal characteristics that explain option and non-use values.

3.2 Evidence

Table 1 displays the studies we have found that estimate the TEV or parts of it and their methods and valued attributes of the transport service, whereas table 2 displays the estimations. Table 1 shows that the most common valued attributes are removal of service and variations in frequency. A majority of the studies analysed specific services in order to derive its TEV, as for instance Humphreys and Fowkes (2006) and Geurs et al. (2006). Laird et al. (2013), on the other hand, evaluated the option value (and non-use values) of bus services (in general) in a national survey. In addition to the national survey they also conducted case studies for evening and weekend services in a low-income suburb and high quality buses in a high-income suburb in Leeds.

In Table 1 and 2 we label the sub-study in the low-income area (a), the high-income area (b) and the national survey (c). The general conclusion drawn by Laird et al. (2013) is that the option value seems to depend on trip characteristics rather than individual characteristics. They also state that for every two regular commuters there might be one person who “uses” the service as an option mode (passively), as a support for work accessibility. However, they also mention that there might be hypothetical biases leasing to overestimations of the option value.

Among the studies listed in Table 1 and 2 Bristow et al. (1991a; 1991b), Crockett (1992), Painter et al. (2002), Chang (2010), Chang et al. (2012) and Wallis and Wignall (2012) used the contingent valuation (CV) approach, the other studies used choice experiments (CE) or a combination of CV and CE. The oldest study in the list, Bristow et al. (1991b), compared a low-income area in Leeds and a rural village in Cheshire with high car and home ownership where they sampled respondents for travel diaries and follow-up interviews. A surprising finding was that the estimates of the TEV for a local bus service were similar between the two areas, despite their difference in socio-economic aspects. Crockett (1992) made a follow up study with a similar approach on a rail link in northern England (Laird et al., 2009). However, both studies had small sample sizes of 30 and 34 households respectively. For a rigorous review of literature prior to 2009, see Laird et al. (2009).

Chang (2010) and Chang et al. (2012) tested a double-bounded dichotomous choice model of train and bus services in Korea. Interestingly, both studies analysed not only closure of services or changes in frequency, but also each respondents intended trip distance. The argument, as expressed in Chang (2010), is that people might put a different option value on longer trips than on shorter trips, which supports the idea of option value as an accessibility indicator. We will return to this argument in sections 3.4.2 and 4. An important note on the values for Chang (2010) and Chang et al. (2012) is that the unit is in euros per kilometre and per hourly number of services as opposed to euros per year for the other studies in table 2. Chang (2010) included a sample of 242 for the estimation of option values and 237 for non-use values, while Chang et al. (2012) sampled 1000 individuals for each of the sub-studies (urban, metropolitan and intercity buses).

Wallis and Wignall (2012) conducted several studies in New Zealand of both bus and rail. In Tables 1 and 2 they are labelled with (a) to (d) for comparison between the tables. When comparing across communities the strongest factors for overall WTP is the service quality in terms of frequency, reliability, travel time, fare and accessibility to destinations. Within communities the most influencing factors were household size and income as well as distance from local centre and expected public transport use. They used household sample sizes between 67-107 for each sub-study.

As a final remark on the tables, we note the study by Johnson et al. (2013) which included valuations for post offices as a comparison to valuations for public transport services on the England countryside, based on a sample of 223 individuals. They found that non-use values declined rapidly with the distance to the service, as opposed to use values that was more stable with regard to distance. In addition, they found smaller values compared to other studies, which they argue might be due to different contexts. However, they argue that option and non-use values are relevant for decisions on public transport subsidies. Laird et al. (2009) supports the argument that option and non-use values are context dependent, and states that the highest valued services in terms of option and non-use values seems to be high quality rail, while the lowest valued services are low quality buses.

Table 1. Valued attributes and methods used

Study	Valued attribute(s)	Method
Bristow et al (1991b)	Removal of service	CV
Crockett (1992)	Removal of service	CV
Roson (2001)	Frequency, property tax	CE
Painter et al. (2002)	Present service, improved service, free service, removal of service	CV
Geurs et al. (2006)	Train travel time, frequency, number of stops, fare, closing of railway	CE
Humphreys and Fowkes (2006)	Train frequency, removal of service, parallel bus route, traffic increase on parallel roads, discount schemes	CV+CE
Chang et al. (2010)	Train frequency, removal of service	CV
Chang et al. (2012)	Bus frequency, removal of service	CV
Wallis & Wignall (2012)	a) Removal of service, bus replacement b) Bus introduction, direct and indirect route c) Introduction of direct bus, train service introduction d) Train introduction, improved bus service	CV
Johnson et al. (2013)	Frequency, local tax, post office service, bus replacement	CE
Laird et al. (2013)	a) Frequency, local tax b) Frequency, travel time, local tax c) Removal of service, local tax	CV+CE

Table 2. Estimates of Option Value (OV), Non-Use value (NUV) and Total Economic Value (TEV)

Study	Unit	Traffic	OV		NUV		TEV	
			low	high	low	high	low	high
Bristow et al (1991b)	Euro/year	Bus					47	179
Crockett (1992)	Euro/year	Bus					46	83
Painter et al. (2002)	Euro/year	Bus					73	308
Geurs et al. (2006)	Euro/year	Rail rural	173	240	104	241		
	Euro/year	Rail regional	146	196	122	328		
Humphreys and Fowkes (2006)	Euro/year	Rail	228	261	-8	69		
Chang (2010)	Euro/kilometre and hourly number of services	Rail conv.	0,010	0,017	0,008	0,013		
		Rail High-speed	0,014	0,024	0,010	0,017		
Chang et al. (2012)	Euro/kilometre and hourly number of services	Bus int.reg	0,012	0,017	0,011	0,016		
		Bus metropol	0,007	0,009	0,006	0,008		
		Bus urban	0,003	0,004	0,002	0,003		
Wallis & Wignall (2012)	Euro/year	Rail (a)	16,5		51,1			
		Rail (c)	4,1		10,7			
		Rail (d)	14,6		31,4			
		Bus (a)	4,3		13,3			
		Bus (b)	9,8		25,9			
		Bus (c)	5,6		14,6			
		Bus (d)	4,2		9,0			
Johnson et al. (2013)	Euro/year	Rail	13,1	28,4	21,2	45,9		
Laird et al. (2013)	Euro/year	Bus low (a)	25,6	32,3	44,5	55,7		
		Bus low (a)	37,8	41,2	51,2	74,6		
		Bus high (b)	12,2		17,8	20,0		
		Bus national survey (c)	41,2		1,1			

Note: All units are expressed in 2014 prices and purchasing power parity has been accounted for.

Roson (2001) studied the significance of option values but did not give quantitative results on its size. Instead, the study tries to tell what kind of individual characteristics that may explain willingness to contribute to the subsidisation of a specific public transport service near their community through taxation. Roson (2001) find that large families are more interested in better public transport services as well as older people. What unites this study with those in table 2 is that all of them approach values other than the active-use value.

3.3 Conclusions from empirical literature

Based on the empirical studies we draw four conclusions regarding what influence the size of the option value. However, we emphasise that the limited amount of literature and the context specifics of the option value are important to bear in mind.

1) Negative correlation between the option value and actual use
   An individual who use a particular service to a large extent do have a smaller option value than those who travel more rarely. The reason is that the expected consumer surplus captures a larger portion of the expected value (Roson, 2001).

2) Uncertainty of demand
   Individuals who are uncertain about their future need for the service place a larger value on the option. The larger the uncertainty, the larger is the portion of the total value that is not captured in the expected consumer surplus (Geurs et al., 2006; Chang et al., 2012).

3) The availability of other option modes
   An individual with several backup modes place a smaller value on each of them. This conclusion might explain why the study in New Zeeland estimated lower values relative to comparable studies (Wallis and Wignall, 2012). Our interpretation is that the high car ownership, and possibly a backup car, is a contributing factor.

4) Quality of service
   The option value seems to be connected to the quality of service. A transport option that provides accessibility to more places, is faster or have better comfort ought to be valued higher. (Laird, et al., 2009)

3.4 Discussion of improvement potentials

In this subsection we address the problems with the division and disaggregation of TEV, and the lack of accessibility measures in previous studies of option and non-use values. Ultimately, this discussion leads to the analysis in section 4, which examines the option value as a component of accessibility.

3.4.1 Division and disaggregation of TEV

According to previous research, the TEV can be divided in various ways (Carson et al., 2001; Chang et al. 2017). A further question is who, or what kind of individuals, that have what kind of value. Laird et al. (2009) identified two types of individuals: users and non-users. Both users and non-users can assign option and non-use values, but only users have a use value. Geurs et al. (2006) on the other hand separates users, option users and non-users.

Ad-hoc taxonomies might however be a result of motives as definition of the values (Carson et al., 2001). This becomes an issue when empirical evaluations are to be divided, and has given rise to different procedures. One is to identify respondents as users, option users or non-users, as in Geurs et al. (2006), Chang (2010) and Chang et al. (2012). The other procedure is to let the respondents themselves decide how much of their total valuation that should be placed on each category. The latter procedure is employed by Wallis and Wignall (2012), Johnson et al. (2013) and Laird et al. (2013). Laird et al. (2013) stress that there is a need for more work on the most appropriate disaggregation method.

3.4.2 Option value as an accessibility indicator

A problem with the empirical studies that we have reviewed is their way of addressing accessibility. All the studies apart from Chang (2010) and Chang et al. (2012) use supply of a certain line as their measure of accessibility. The use of supply is an example of an infrastructure based accessibility measure (Geurs and van Wee 2004). The use of infrastructure based accessibility measures has both advantages as well as shortcomings.

The most significant shortcoming in this context is that it is not easy to translate it into accessibility as it is defined in section 2.2 (originally by Geurs and van Wee (2004)). In other words, the level of service on a specific service does not tell you anything about the accessibility level of a certain individual. This leads to an inability to link the valuations presented above to the accessibility contribution of the supply.

In order to generalise the valuation, it has to relate to the accessibility improvement. And to do this, the original level of accessibility has to be known as well as the absolute accessibility contribution of the studied supply. These two can then be combined to obtain the relative accessibility contribution of the supply. This can then be valued, generalised and used in appraisal. Thus, the valuation of the option should be a function of not only the studied accessibility change but also the original accessibility level.

The only two studies that take a step in this direction are Chang (2010) and Chang et al. (2012). They calculate the TEV as a function of the supply expressed as distance and frequency. Since the valuation is a function of the features of the supply rather than the supply itself, the valuation can be applied to other services – given that the level of accessibility is the same as in the original study. This is off course a radical assumption, especially if one wishes to have an individual-based view on accessibility.

4. Option value and accessibility

4.1 Accessibility perspective

As mentioned above, previous studies have with few exceptions studied individual public transport services without studying how much accessibility they actually provide. Neither have they put it in relation to the total level of accessibility (e.g. of the each individual). This has led to the inability to study the option value of the relative accessibility contribution that the studied services provide.

One of the most sophisticated measures of accessibility is the logsum measure (Geurs & van Wee, 2004; de Jong et al., 2007). The logsum measure have several features that make it an attractive measure, in particular that it takes into account 1) the benefit of reaching a destination 2) the cost of doing so and 3) that every additional destination adds accessibility. If used on an individual level it also fulfils the definition of accessibility presented in section 2.2.

However, the logsum measure, as well as the value of time used in appraisal, is based on past behaviour. Trips already undertaken have no uncertainty associated with them, and therefore no option value. Future trips on the other hand have uncertainty associated with them. This will result in a demand for several destinations and modes up until the moment the actual trip is undertaken. Given that the individual who is about to make a trip is risk averse, he or she will be willing to pay a risk premium to keep several destinations and modes available. This risk premium is an additional accessibility component, a component not even included in the logsum.

We argue that the three features of the logsum listed above can be used to gain a greater understanding of the size of the premium (option value) in any given situation. Imagine a simplified world like the one in Figure 2. The large circle is the origin and the two smaller ones, A and B, are the possible destinations. The arrows, 1, 2 and 3, are possible modes.

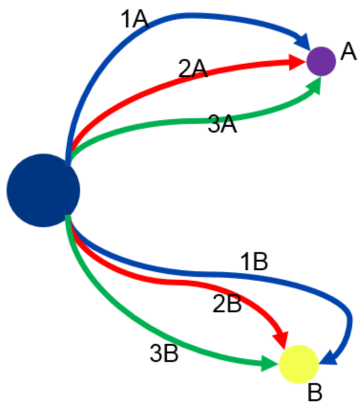

Figure 2. Two destinations and three modes

$$2A > 3B > 1A$$

Imagine an individual, whose preferred trip at a given situation is mode 2 to destination A, trip 2A. This trip gives rise to the largest net benefit for the individual. The trip that gives rise to the second largest net benefit is mode 3 to destination B, trip 3B. The trip with the third largest net benefit is mode 1 to destination A, trip 1A. If trip 3B is unavailable at the same time that trip 2A is unavailable the individual experiences a welfare loss equal to the size of the difference between the net benefit trip 2A would have given and the actual net benefit of trip 1A. It is against this welfare loss the individual insures herself by keeping trip 3B available.

This welfare loss has to be put in relation to the uncertainty the individual perceive due to the risk that trip 2A is unavailable. For the same reasons the individual may be willing to pay a premium to keep a certain mode or destination available. From this follows that the individual may be willing to insure herself by keeping other trips than 3B available, for example trip 1A.

The option value of trip 1A in the situation described above is dependent on the risk that both the preferred trips, 3B and 2A, are unavailable at the same time. The individual's willingness to pay will then be a function of the welfare difference between the fourth best trip and the best trip as well as the risk that both 2A and 3B are unavailable at the same time.

Since there is a risk that 3B and 1A is unavailable at the same time the expected welfare loss when 2A is unavailable is greater than the difference between 2A and 1A. How much greater is determined by the correlation of the risk that 3B and 1A is unavailable at the same time. This realisation leads to the conclusion that the individual, in a situation where some relatively good options unavailability is highly correlated, will be willing to pay a relatively high premium to keep a relatively poor option available given that its risk of unavailability has a low correlation with the risk of unavailability of the good options.

The benefit an individual receives from a certain trip varies over time depending on what the individual demands at any given time, as well as how arduous it perceives these trips. The uncertainty the individual insures herself thus consists of two types of uncertainty. One is the one discussed earlier in this section, the uncertainty of supply, in this case the availability of transport services. The other type of uncertainty is the uncertainty of demand. The individual does not with certainty know which services she will demand in the future due to uncertainty about future preferences and will thus be willing to pay a premium to keep several options available to her.

When breaking down the composition of the option value as done above, some conclusions can be drawn. Given that individuals are risk adverse, they are willing to pay a premium to keep every single option available. The size of the premium is a function of the individual's preferences in terms of demand, the options available, the quality of these options and how the risks of unavailability of the options as well as the individuals demand of the options is correlated. If there are many similar options and the risk of these options being unavailable (or undesired) is highly correlated, the individual will have a low willingness to pay to keep them available (low option value). If on the other hand, there are a wider quality variety among the options and a relatively good options risk of unavailability is fairly uncorrelated with the other options the willingness to pay to keep the option available will be high (high option value).

As long as the risks of unavailability (or undesirability) are not perfectly correlated, every additional option will reduce the total risk of not fulfilling the individual needs. Therefore, individuals will have a willingness to pay, an option value, for every additional option. This feature along with what has been shown above (that the premium, or option value, is a function of the benefit of reaching a destination as well as the cost of doing so), are the same as the desirable characteristics of the logsum measure of accessibility identified in the beginning of this section. In the same way as with the logsum, the benefit of each additional option is lower than the last.

4.2 Conclusions from accessibility analysis

After building a model to view the option value based on the logsum and the definition of accessibility in section 2.2 other conclusions emerge than those based on the empirical findings. The four main conclusions regarding what influences the size of the option value of a certain trip are as follows:

a) The options and the quality of these
That the costs and benefits, i.e. the quality, of the available trips affect the option value of the other trips is fairly trivial. What individuals perceive as high quality varies both over individuals but also over time. Regardless, options of higher quality should have a higher option value than options of lower quality.

b) Uncertainty of future supply
An option cannot have an option value if it is not available. If the individual perceives the future ability to make a certain trip as uncertain it will have a lower willing to pay to keep it available than if its future availability was certain.

c) Uncertainty of future demand
A significant proportion of the uncertainty stems from the individuals own uncertainty about its future demand. The individual cannot with certainty know what he/she will demand in the future. To manage this uncertainty it will want to insure itself by keeping many options available to her. This uncertainty in combination with the uncertainty of future supply forms the total uncertainty concerning which trips the individual both desire to, and can, undertake in the future.

d) Correlation between probabilities
If a certain trip is unavailable at the same time it is demanded it has no value. This implies that the correlation between the probability that a certain trip being unavailable and demanded affects the option value negatively. For example if trip A in unavailable at the same time as trip B, trip A cannot be used as an insurance against the unavailability of trip A. Conversely, a low correlation of the probabilities makes trip A a good insurance against the unavailability of trip B.

5. Discussion and conclusions

Before going into a discussion of our conclusions we note that the literature on option values in transport is rather fragmented. While definitions of the components of the total economic value (TEV) are established there is no real agreement about how to categorise them in terms of TEV. Some categorise option value as a use value (or benefit) while others argue that it is a non-use value. One can avoid the categorising difficulty by distinguish passive-use values and active-use values (Carson et al. 2001).

Based on the empirical literature we draw four conclusions about what seem to influence the option value for public transport. (1) There is a negative relationship between the use of the service and the option value. That is, the relative importance of option and non-use values decline where use benefits are high. (2) Related to the first conclusion is the uncertainty of future demand. The more unsure individuals are of the likelihood of demanding the service in the future, the more they value having it as insurance. If one use a service daily the uncertainty about future trips becomes small, so (1) and (2) are somewhat overlapping. (3) The availability and quality of other reserve (option) modes influence the option value for each of them. (4) The quality of the public transport service influences the option value positively. This might explain why train services seem to have a larger option value than bus services (Laird et al., 2009).

The theoretical analysis in section 5, based on a broader approach to accessibility, reinforced two of the conclusions drawn from the empirical review in section 4, but we also drew two more. We found that (a) it is dependent on the quality of the options (similar to (4) above); (b) the uncertainty of future supply; (c) the uncertainty of future demand, which is also mentioned in (2); and (d) the correlation of probabilities that transport modes are unavailable simultaneously.

The general advantage with connecting the option value to what accessibility it contributes to is that it is not the trip itself that gives rise to values, but the actual, or potential, benefit of reaching the destination. We emphasise that the mere existence of a service might not be valued; instead it is the potential accessibility it contributes to that is valued. Thus, based on the definition of accessibility in section 2.2, analyses should aim to examine the added accessibility that an option mode gives to an individual.

In conclusion, the reason for people to pay high costs and move to agglomerations of opportunities such as cities can in part be explained by the existence of option values. People living in small towns may have very good accessibility to their work by one or two transport modes, whereas people in larger cities get access to many different opportunities and their accessibility is supported by several transport modes.

This study has sought to bring new knowledge about the option value in a public transport context, but there is still much ground to cover on the topic. Many of the papers we have encountered emphasise the lack of knowledge about option values (for instance Laird et al. (2009), and we argue that both theoretical and empirical contributions are necessary to answer whether these values are relevant. The risk of double counting values is presumably large and therefore we state that it is important to relate these values to the consumer surplus, before including them in appraisals.

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